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Matsuda et al.

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(54) **ENGINE FOR PERSONAL WATERCRAFT AND CRANKSHAFT THEREOF**

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(52) **U.S. Cl.** ..... **123/198 A**; 123/195 A; 123/90.31
(58) **Field of Search** ..... 123/195 A, 90.31

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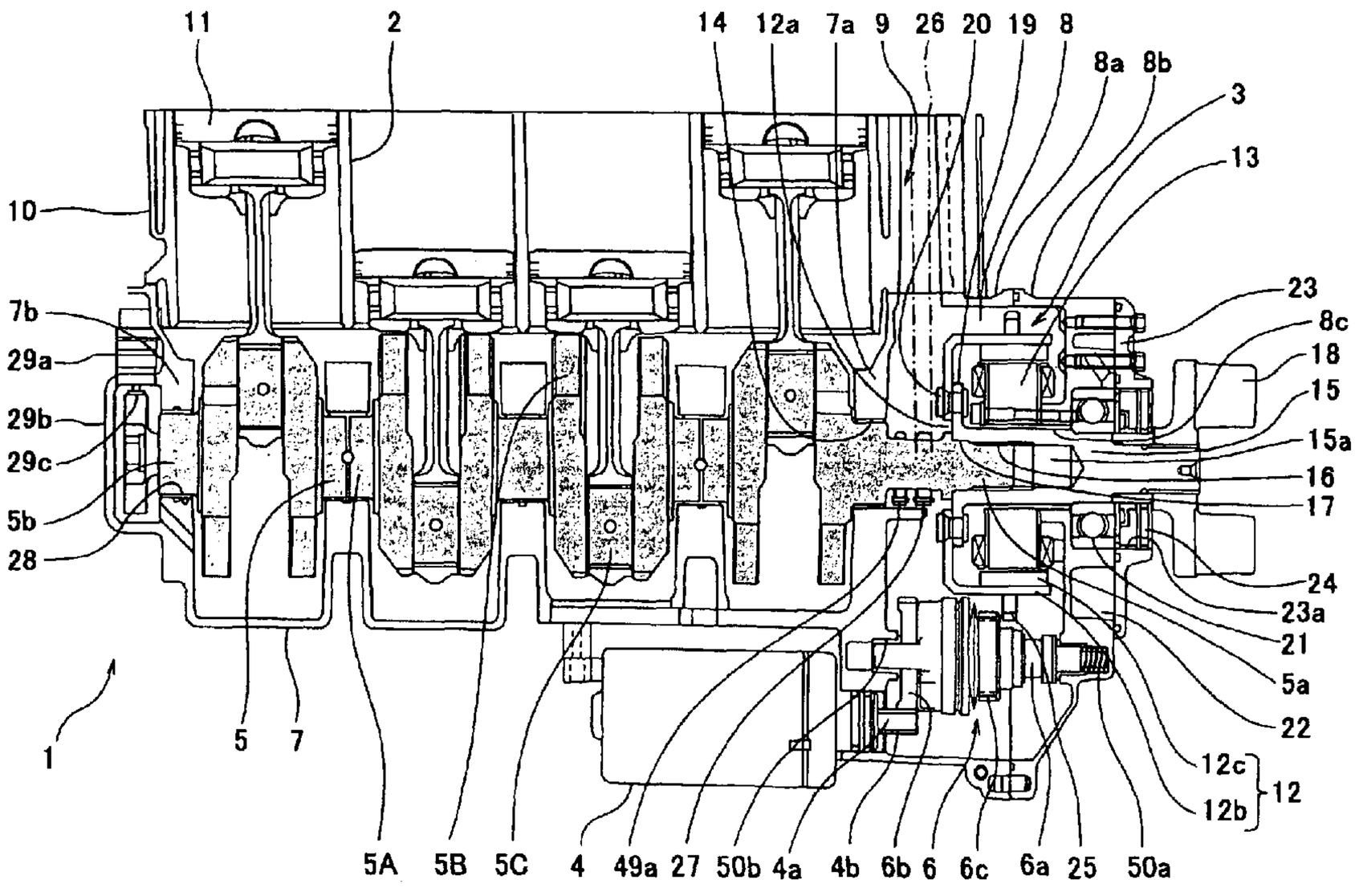
(57) **ABSTRACT**

Disclosed is an engine of a personal watercraft having a water jet pump at a rear end thereof, in which a center of gravity of the engine is located rearward for improvement of planing capability of the watercraft. The engine comprises: a crankcase having a front end wall and a rear end wall; a crankshaft provided inside the crankcase; a generator provided at an output end portion of the crankshaft, the generator including a rotor fixed to the crankshaft; a starter motor provided on an output end side of the crankshaft outside the crankcase; and a clutch provided between the starter motor and the rotor of the generator, for connecting/disconnecting the starter motor to/from the rotor.

10 Claims, 6 Drawing Sheets



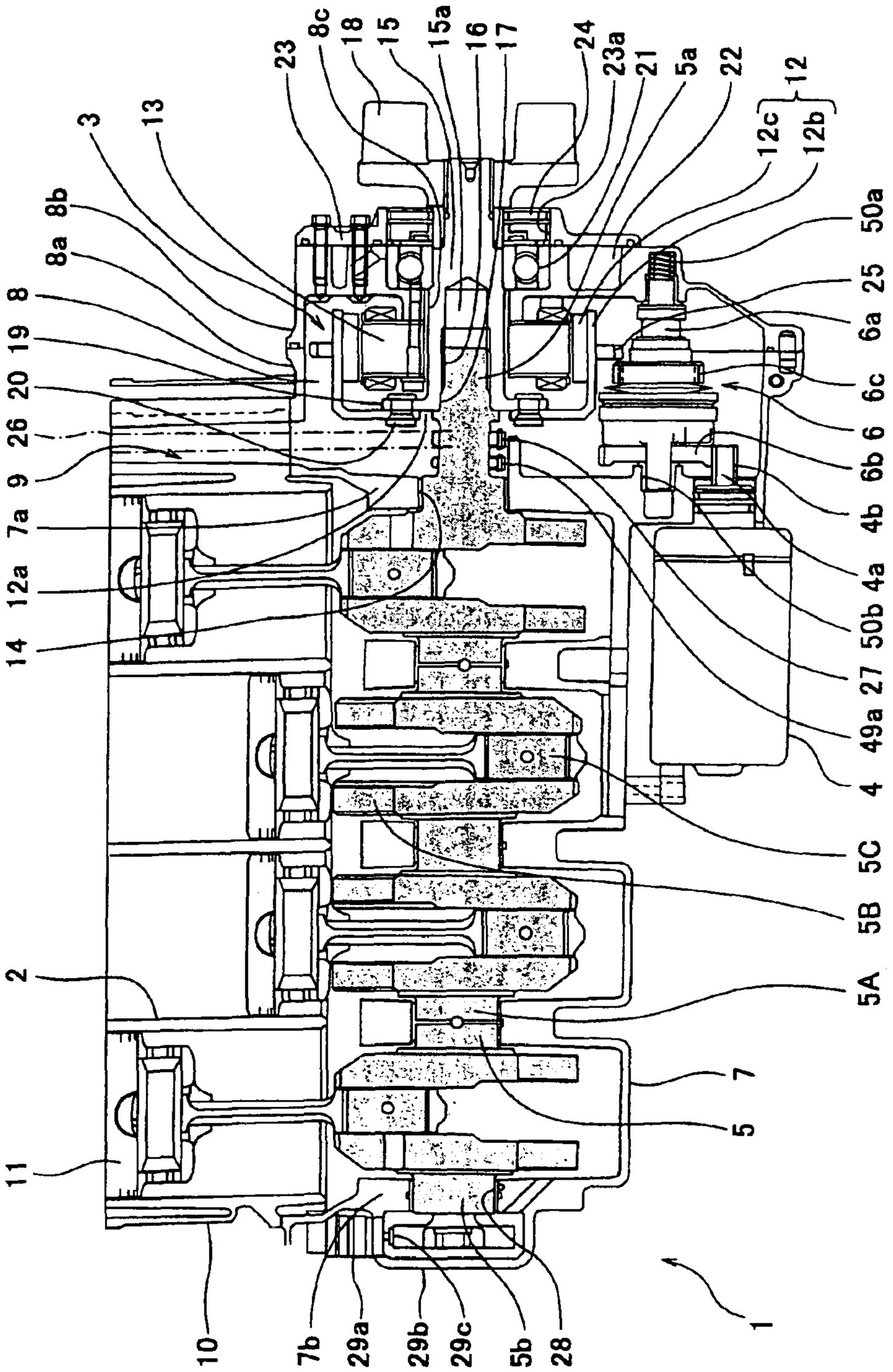

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Fig. 1

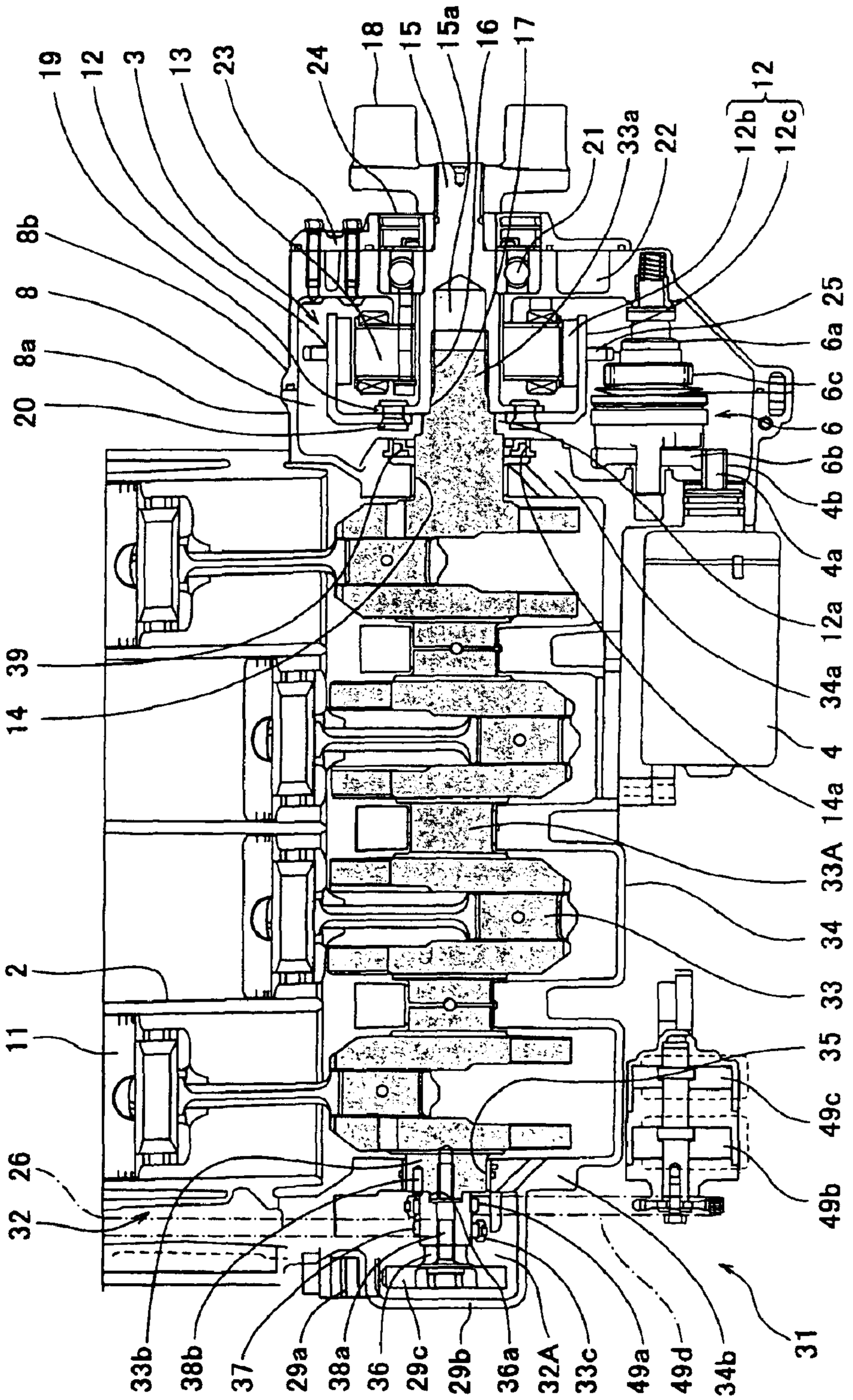
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Fig. 2

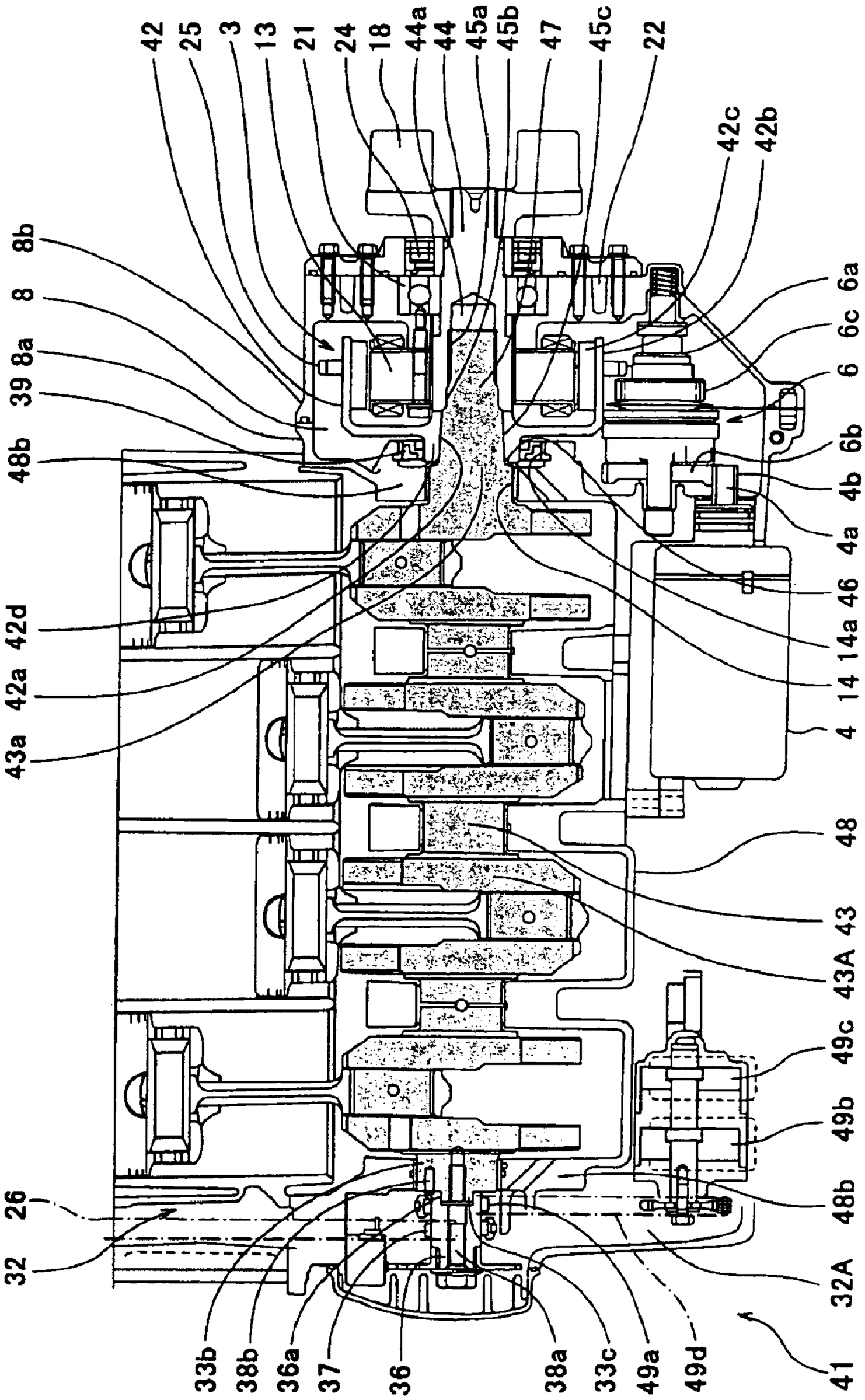
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Fig. 3

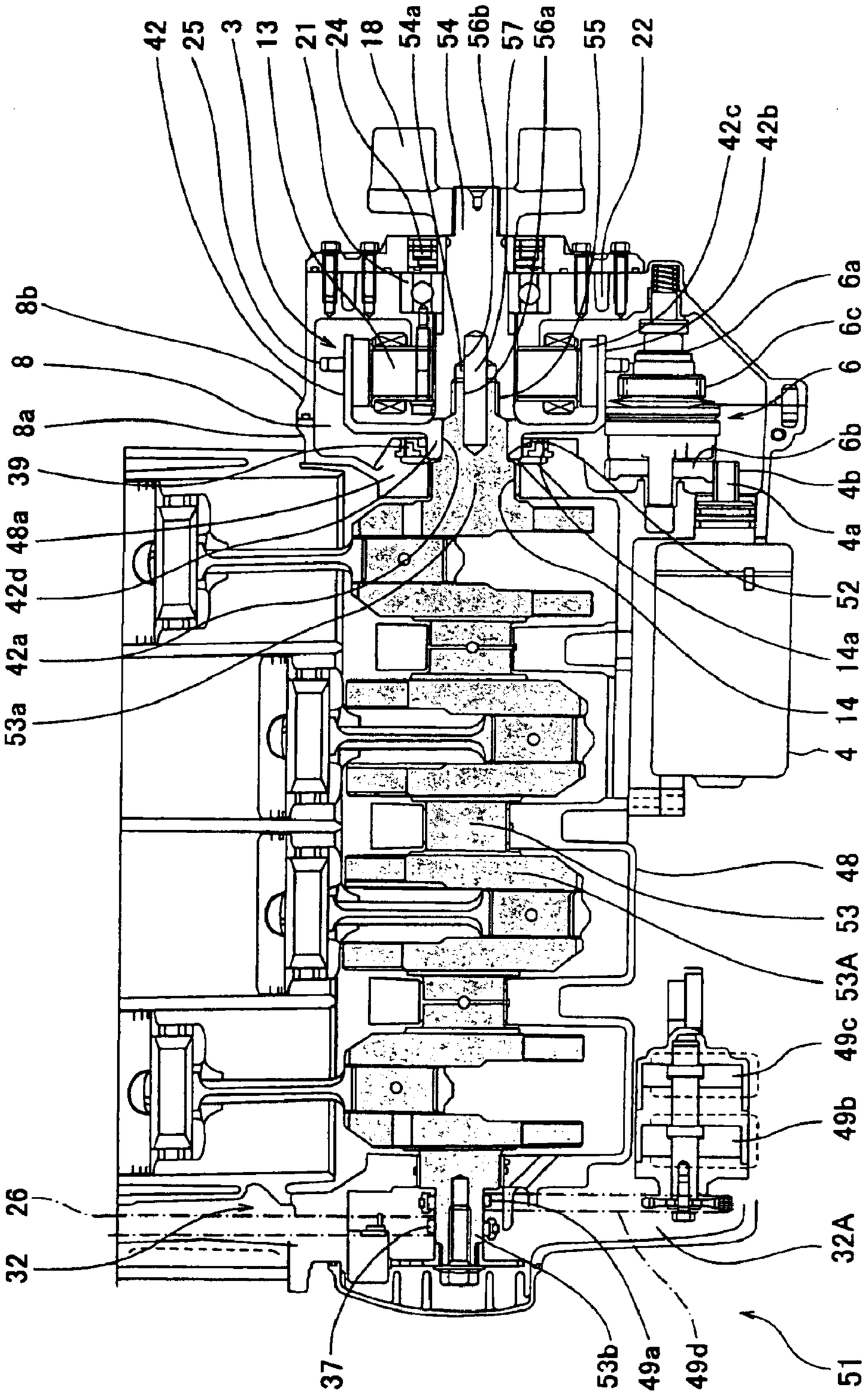
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Fig. 4

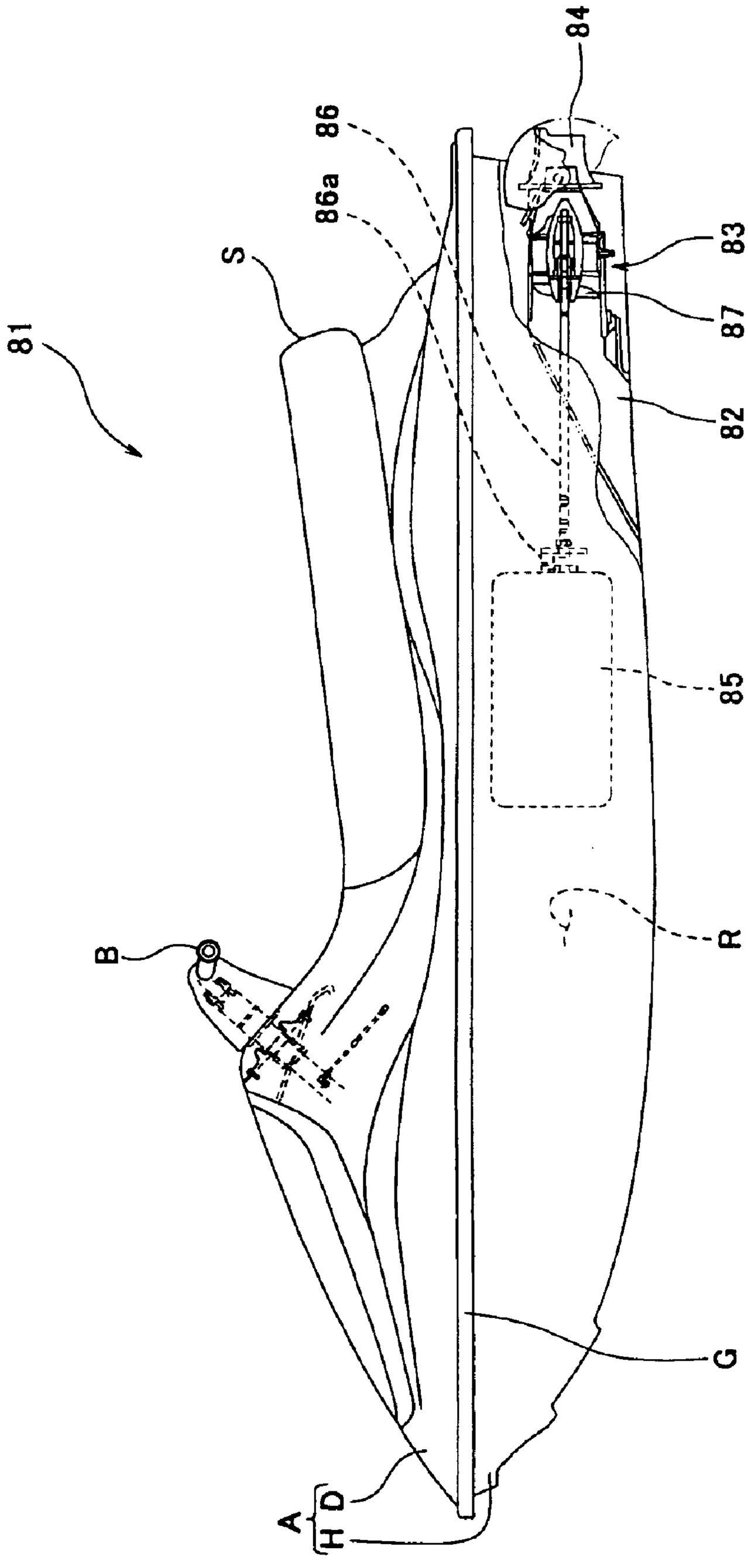
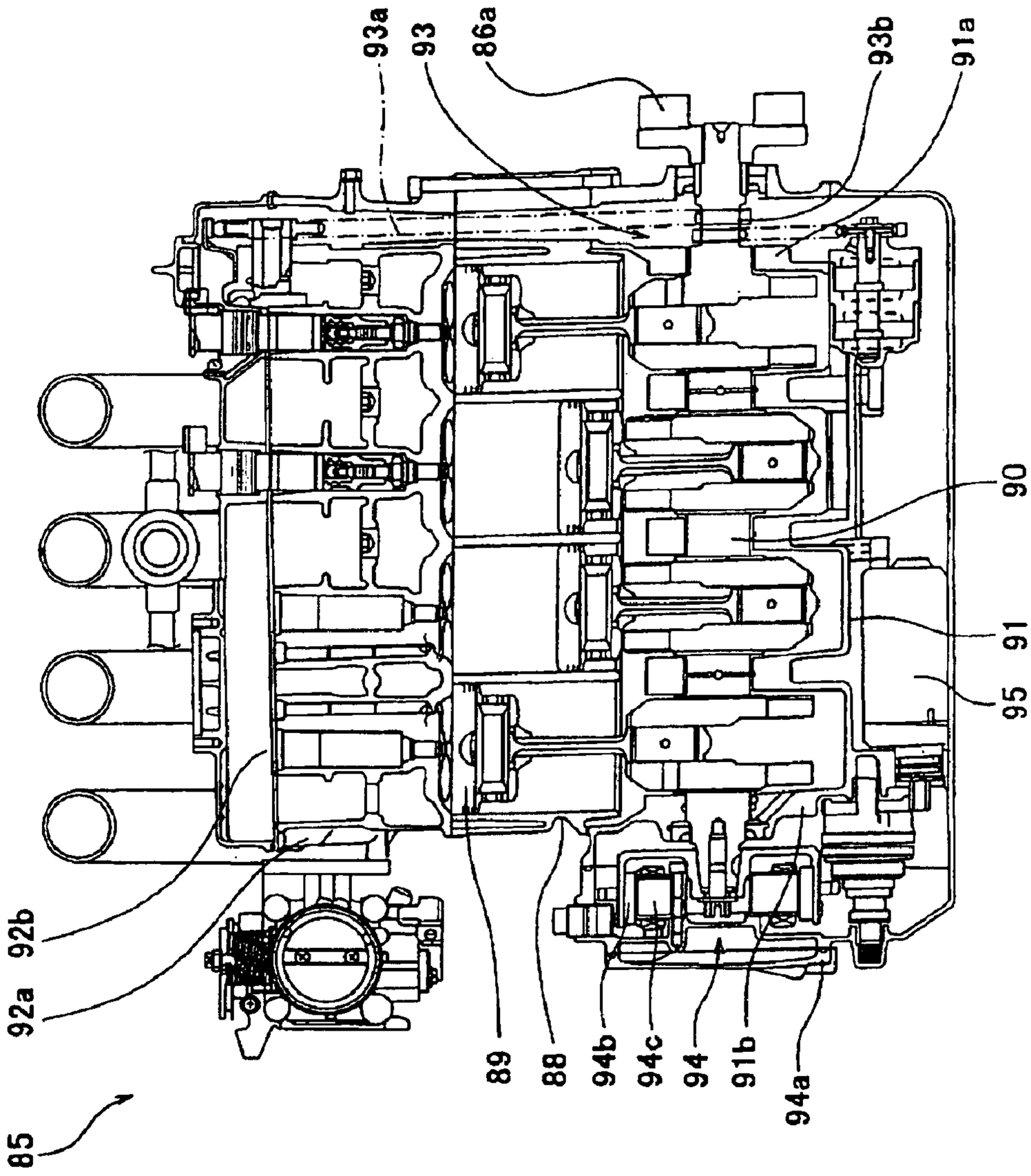


Fig. 5



PRIOR ART

Fig. 6

ENGINE FOR PERSONAL WATERCRAFT AND CRANKSHAFT THEREOF

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an engine for a personal watercraft and a crankshaft thereof. More particularly, the present invention relates to an engine mounted in a body for driving a propulsion device of a personal watercraft that ejects water rearward and planes on a water surface as the resulting action, and a crankshaft suitable for the engine.

In recent years, so-called jet-propulsion personal watercraft (PWC) have been widely used in leisure, sport, rescue activities, and the like. FIG. **5** shows an example of such personal watercraft.

In a personal watercraft **81** in FIG. **5**, A denotes a body of the watercraft. The body A comprises a hull H and a deck D covering the hull H from above. A line at which the hull H and the deck D are connected over the entire perimeter thereof is called a gunnel line G. L denotes a waterline in a state of the watercraft.

A straddle-type seat S is mounted onto an upper surface of the body A so as to extend substantially from a center portion to a rear portion over the deck D along the longitudinal direction of the watercraft **81**. Straddling the straddle-type seat S, the rider grips a steering handle B located forward of the seat S and steers the watercraft. Hereinafter, "forward" refers to the direction toward which the watercraft moves and "rearward" refers to the opposite side.

The personal watercraft **81** is configured to have a water jet pump **83** that pressurizes and accelerates water sucked from a water intake **82** generally provided on a hull bottom surface of the body A and ejects the water rearward through a steering nozzle **84**. Thereby, the body A is propelled. An engine **85** for driving the water jet pump **83** is contained in an engine room R located below the seat S. A propeller shaft **86** is connected to an output shaft of the engine **85** and an impeller **87** of the water jet pump **83** is attached on the propeller shaft **86**.

Commonly, a two-cycle engine is mounted in the personal watercraft as the engine **85**. Recently, in addition to this, the use of a four-cycle engine has been proposed.

FIG. **6** shows an example of the four-cycle engine. The engine **85** is a four-cylinder engine and is placed such that cylinders are arranged along the longitudinal direction of the body A (FIG. **5**). Reference numeral **88** denotes a cylinder, **89** denotes a piston, **90** denotes a crankshaft, **91** denotes a crankcase, **92***a* denotes a cylinder head, and **92***b* denotes a head cover. A cam chain tunnel **93** is formed in a rear end portion of the engine **85**, and a generator **94** and a starter motor **95** are mounted in a front end portion of the engine.

A rear end portion of the crankshaft **90** of the engine **85** penetrates through a rear end wall **91***a* of the crankcase **91** and penetrates through the cam chain tunnel **93** so as to protrude outwardly in the rear end of the engine **85**. A coupling **86***a* for connecting the propeller shaft **86** (FIG. **5**) is mounted to the rear end of the crankshaft **90**. A sprocket **93***b* for a cam chain **93***a* is mounted to a position of the crankshaft **90** inside the cam chain tunnel **93**. Meanwhile, a front end portion of the crankshaft **90** penetrates through a front end wall **91***b* of the crankcase **91** and protrudes into a housing **94***a* covering the generator **94**. A rotor **94***b* of the generator **94** is mounted to the front end portion of the crankshaft **90**. A stator **94***c* of the generator **94** is fixed to the housing **94***a*.

Since the above-structured engine has weight more than that of the two-cycle engine, it is desirable to position the engine in the personal watercraft so as to minimize the effect of the engine having more weight on cruising attitude of the watercraft. However, since placement of the engine is restricted by the space of the engine room of the personal watercraft, it is difficult to greatly change the position of the engine. For the purpose of improvement of the cruising attitude of the personal watercraft, it is desirable to locate a center of gravity of the four-cycle engine closest to the rear of the personal watercraft.

In order to obtain a power as high as that of the two-cycle engine in the four-cycle engine without an increase in displacement of the engine, increases in an engine speed and the number of cylinders are effective.

However, with the increase in the number of the cylinders, it becomes necessary to increase the length of the crankshaft **90**. It would be difficult to manufacture a longer crankshaft in the conventional manufacturing apparatus, and therefore, there arises a need for a manufacturing apparatus capable of manufacturing the longer crankshaft. But, the manufacturing apparatus of the crankshaft having a complex shape and requiring high accuracy would be complex and expensive.

SUMMARY OF THE INVENTION

The present invention addresses the above-described conditions, and an object of the present invention is to provide an engine having a center of gravity located rearward to be suitable for a personal watercraft, and a crankshaft suitable for the engine.

According to the present invention, there is provided an engine of a personal watercraft having a water jet pump at a rear end thereof, comprising: a crankcase having a front end wall and a rear end wall; a crankshaft provided inside the crankcase; a generator provided at an output end portion of the crankshaft, the generator including a rotor fixed to the crankshaft; a starter motor provided on an output end side of the crankshaft outside the crankcase; and a clutch provided between the starter motor and the rotor of the generator, for connecting/disconnecting the starter motor to/from the rotor.

With such a structure, since the generator, the starter motor, the clutch and the like of the engine, which have relatively large weight, are located on the output end side of the engine, a center of gravity of the engine is advantageously located rearward in the engine so as to be suitable for the watercraft. Since the generator and the starter motor are placed on the output end side of the engine, the clutch is correspondingly placed on the output end side of the engine. As defined herein, the output end side refers to the rear side of the engine.

Preferably, the engine may further comprise: a cam chain tunnel formed in a front portion of the front end wall of the crankcase on an opposite side of the output end side of the crankshaft; and a sprocket for driving a cam mechanism of the engine, the sprocket being mounted to an end portion of the crankshaft passing through a penetrating hole formed in the front end wall of the crankcase and protruding into the cam chain tunnel.

With such a structure, the diameter of the sprocket can be selected irrespective of the diameter of output end side of the crankshaft adapted to transmit an output of the crankshaft to the propeller shaft. This reduces the diameter of the sprocket. As a result, a lightweight and compact engine is achieved. Therefore, for the watercraft, it is preferable to place the cam chain on the opposite side (front end side of the engine) of the output side of the crankshaft.

Preferably, the engine may further comprise: a generator chamber formed in a rear portion of the rear end wall of the crankcase, for containing the generator, the output end portion of the crankshaft may pass through a penetrating hole formed in the rear end wall of the crankcase and protrudes into the generator chamber, and a seal member may be provided in the penetrating hole of the crankcase to seal between an inside of the crankcase and the generator chamber. In this structure, since an oil inside the crankcase is prevented from flowing into an inside of the generator chamber, the loss of a rotational energy of the rotor of the generator which would be caused by viscosity of the oil is avoided.

Preferably, the engine may further comprise a water jacket formed in a housing constituting the generator chamber to allow cooling water to flow therethrough. With this structure, the generator and its vicinity are cooled more effectively.

The engine may comprise a generator chamber formed in a rear portion of the rear end wall of the crankcase, for containing the generator; a cam chain tunnel communicating with an inside of the generator chamber; and a sprocket for driving a cam mechanism, the sprocket being mounted to a portion of the crankshaft between the rotor and the penetrating hole in the generator chamber, and the rotor is mounted to the output end portion of the crankshaft passing through a penetrating hole formed in the rear end wall of the crankcase and protruding into the generator chamber. Such a structure is advantageous in that the generator and its vicinity are efficiently cooled by the oil dropping through the cam chain tunnel although a slight loss of the rotational energy of the rotor of the generator occurs due to the oil.

According to the present invention, there is provided a crankshaft of an engine for a personal watercraft, comprising: a crankshaft body; a first extended shaft member connected to one end portion of the crankshaft body so as to be rotatable integrally with and separable from the crankshaft body; and a rotor-mounting portion provided at an end portion of the crankshaft on the first extended shaft member side, for mounting a rotor of a generator of the engine, and the first extended shaft member constitutes an output end part of the engine.

With such a structure, the crankshaft body is shortened. Consequently, manufacturing the crankshaft becomes easy. In addition, the generator can be easily placed in the output end side of the crankshaft.

Preferably, the rotor-mounting portion may be formed integrally with the first extended shaft member. With this structure, the rotor of the generator is easily placed on the output end side of the crankshaft.

Preferably, the crankshaft body may comprise an extended shaft mounting portion for connecting the first extended shaft member and the rotor-mounting portion in this order as seen from the one end portion of the crankshaft body, and the first extended shaft member may be mounted to the extended shaft mounting portion to thereby allow the rotor of the generator to be fixed to the rotor-mounting portion. With this structure, the rotor of the generator is easily placed on the output end side of the crankshaft.

The crankshaft may further comprise a coupling for taking out an output of the engine, the coupling being provided at a rear end portion of the first extended shaft member. Thereby, the output of the engine can be easily taken out.

Preferably, the crankshaft may further comprise a second extended shaft member connected to the other end portion of the crankshaft body to be rotatable integrally with and separable from the crankshaft body; and a sprocket-mounting portion for mounting a cam-driving sprocket on the second extended shaft member. With this structure, the crankshaft body is shortened, and therefore manufacturing the crankshaft becomes easy. The crankshaft is applied to an engine having a cam chain tunnel at a front portion thereof.

The crankshaft may comprise: a sprocket-mounting portion formed at the one end portion of the crankshaft body adjacent the first extended shaft member, for mounting a cam-driving sprocket of the engine. Such a crankshaft is suitably used in the engine having the cam chain tunnel communicating with an inside of the generator.

Preferably, in the crankshaft, a connecting hole may be formed in an end portion of the first extended shaft member for connecting the crankshaft body by inserting the one end portion of the crankshaft body thereinto, an outer peripheral face of the one end portion of the crankshaft body and an inner peripheral face of the connecting hole of the first extended shaft member may respectively have a cylindrical fitting face for centering, and an engagement portion for preventing circumferential relative rotation between the crankshaft body and the first extended shaft member. A center axis of the fitting face of the crankshaft body corresponds with a rotational center axis of the crankshaft and a center axis of the fitting face of the first extended shaft member corresponds with a center axis of the first extended shaft member. With such a structure, the crankshaft body can be made shorter.

According to the present invention, there is provided an engine of a personal watercraft comprising: a crankcase having a front end wall and a rear end wall; a crankshaft provided inside the crankcase; a generator provided at an output end portion of the crankshaft, the generator including a rotor fixed to the crankshaft; a starter motor provided on an output end side of the crankshaft outside the crankcase; a clutch provided between the starter motor and the rotor of the generator, for connecting/disconnecting the starter motor to/from the rotor, the crankshaft includes: a crankshaft body; a first extended shaft member having a tip end portion and a base end portion and connected to an end portion of the crankshaft body so as to be rotatable integrally with and separable from the crankshaft body; and a rotor-mounting portion provided at an end portion of the crankshaft on the first extended shaft member side, for mounting the rotor of the generator, and the first extended shaft member constitutes an output end part of the engine. With this structure, the center of gravity of the engine is located rearward to be suitable for the personal watercraft, and manufacturing the engine becomes easy.

The above and further objects and features of the invention will be more fully apparent from the following detailed description with accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a longitudinal sectional view showing a portion including a crankshaft of an engine for a personal watercraft according to an embodiment of the present invention;

FIG. **2** is a longitudinal sectional view showing a portion including a crankshaft of an engine for a personal watercraft according to another embodiment of the present invention;

FIG. **3** is a longitudinal sectional view showing a portion including a crankshaft of an engine for a personal watercraft according to another embodiment of the present invention;

FIG. **4** is a longitudinal sectional view showing a portion including a crankshaft of an engine for a personal watercraft according to another embodiment of the present invention;

FIG. **5** is a partially cross-sectional side view showing an example of a personal watercraft capable of mounting the engine of the present invention or the conventional engine; and

FIG. **6** is a longitudinal sectional view showing the conventional engine of the personal watercraft.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, embodiments of an engine of a personal watercraft of the present invention will be described with reference to the accompanying drawings.

FIG. **1** is a longitudinal sectional view showing main components including a crankshaft of an engine of a personal watercraft according to an embodiment of the present invention.

An engine **1** of this embodiment is a multi-cylinder (for example, four-cylinder) four-cycle engine. The engine **1** is mounted in the watercraft such that cylinders **2** are arranged along the longitudinal direction of a body of the watercraft (not shown) like the conventional engine **85** (see FIG. **6**). Therefore, a crankshaft **5** of the engine **1** is placed along the longitudinal direction of the body and an output end portion thereof is connected to a propeller shaft of the watercraft (not shown). The propeller shaft functions to drive a water jet pump provided at a rear portion of the watercraft. The propeller shaft extends rearwardly from the output end portion of the crankshaft **5** and is connected to the water jet pump.

In the engine **1**, a generator **3**, a starter motor **4**, and a clutch **6** for connecting/disconnecting the starter motor **4** to/from the crankshaft **5** are located in the vicinity of the rear end of the engine **1**. Here, "front" refers to the direction toward which the body of the watercraft moves and "rear" refers to the opposite direction. More specifically, a coupling **18** for connecting the propeller shaft mentioned later is located on the "rear" side.

In FIG. **1**, reference numeral **7** denotes a crankcase, **8** denotes a generator chamber that contains the generator **3**, **9** denotes a cam chain tunnel, **10** denotes a cylinder block, and **11** denotes a piston. A cylinder head and a cylinder head cover provided over the cylinder block **10** are not illustrated in FIG. **1**. The clutch **6** is accommodated in the generator chamber **8** together with a rotor **12** of the generator **3** and a stator **13** of the engine. The generator chamber **8** is comprised of a body portion **8***a* formed integrally with the crankcase **7** so as to open outside at a rear end thereof, and a first lid member **8***b* removably attached to the body portion **8***a* to close the open part of the body portion **8***a*.

A cam chain tunnel **9** that contains a cam chain **26** is provided in a rear portion of a rear end wall **7***a* of the crankcase **7**. The cam chain tunnel **26** extends from the body portion **8***a* of the generator chamber **8** to the cylinder head (not shown) through an inside of the cylinder block **10**. The cam chain **26** serves to transmit rotation of the crankshaft **5** to a camshaft provided on the cylinder head. The crankshaft **5** comprises a crankshaft body **5**A (expressed as colored in FIG. **1**) having a crank web **5**B, a crank pin **5**C and the like, and a first extended shaft member **15** as an output end part of the crankshaft **5**.

A rear end portion **5***a* of the crankshaft body **5**A passes through a penetrating hole **14** formed in a rear end wall **7***a* of the crankcase **7** so as to be rotatably supporting the crankshaft **5** and protrudes into an inside of the generator chamber **8**. The rear end portion **5***a* has a screw portion **16**. The screw portion **16** is screwed into an inner thread formed in a connecting hole **15***a* of the first extended shaft member **15** such that the first extended shaft member **15** can rotate integrally with the crankshaft body **5**A. Alternatively, the first extended shaft member **15** may be connected to the crankshaft body **5**A so as to be integrally rotatable by any suitable means, including by a spline connection. In this embodiment, in the portion where the rear end portion **5***a* is fitted to the first extended shaft member **15**, the screw portion **16** is formed on a rear end side of the rear end portion **5***a* and a centering location portion **17** is formed adjacent a front end side of the screw portion **16** (on the opposite side of the rear end side). In the centering location portion **17**, an outer peripheral face of the rear end portion **5***a* is fitted to a corresponding inner peripheral face of the connecting hole **15***a* of the first extended shaft member **15** without substantial clearance. The outer peripheral face of the rear end portion **5***a* and the corresponding inner peripheral face of the first extended shaft member **15** are respectively formed concentrically with a rotational center axis of the crankshaft **5**.

The first extended shaft member **15** passes through a penetrating hole **8***c* formed in the first lid member **8***b* of the generator chamber **8** and protrudes outwardly. The coupling **18** for connecting the propeller shaft (not shown) is connected by a spline to a rear end portion (output end portion) of the outwardly protruding first extended shaft member **15**. The portion where a spline groove is formed constitutes a coupling mounting portion. The rotor **12** of the generator **3** is mounted to an outer periphery of a portion of the first extended shaft member **15** which is located inside the generator chamber **8** so as to be integrally rotatable. More specifically, an outwardly extending flange **19** of a circular-ring shape is formed at an outer periphery of a front end of the first extended shaft member **15**. The rotor **12** is of a cylinder shape having a bottom and is mounted to the flange **19** by means of a rivet **20**. An opening **12***a* is formed in the bottom of the rotor **12** to allow the rear end portion **5***a* of the crankshaft body **5**A to be inserted thereinto. A magnet **12***c* is fixed to the inner peripheral face of a cylindrical body portion **12***b* of the rotor **12**.

A stator **13** of the generator **3** is removably mounted to the first lid member **8***b* of the generator chamber **8**. The penetrating hole **8***c* formed in the first lid member **8***b* has an increased diameter in a rear portion thereof and a bearing **21** is mounted in the increased-diameter portion for rotatably supporting the first extended shaft member **15**. A concave portion **22** is formed in an outer face of the first lid member **8***b* to allow cooling water to flow therethrough. A second lid member **23** is removably attached to close the concave portion **22**. In this embodiment, the concave portion **22** is circularly formed in the first lid member **8***b* around the bearing **21**, and constitutes a water jacket for introducing the cooling water. The water jacket serves to cool the generator **3**, the bearing **21**, an oil dropping from the cam chain tunnel **9**, and the like. A seal member **24** is provided in a penetrating hole **23***a* of the second lid member **23**, through which the first extended shaft member **15** penetrates.

The water jacket of this embodiment is formed in the rear end wall of the first lid member **8***b* to surround the bearing **21**. Instead, the water jacket may be provided at an outer peripheral wall of the generator chamber **8** or the like, as necessary.

The clutch **6** is accommodated in the generator chamber **8** in such a manner that both ends of a shaft **6***a* of the clutch **6** are supported by support holes **50***a*, **50***b* formed in the crankcase **7** and the first lid member **8***b*, respectively. An output shaft **4***a* of the starter motor **4** mounted to an outer

face of the side wall at the rear portion of the crankcase **7** protrudes into the generator chamber **8**. A gear **4***b* provided on the output shaft **4***a* is in mesh with a first gear **6***b* provided on the shaft **6***a* of the clutch **6**. A second gear **6***c* is provided on the shaft **6***a* of the clutch **6** so as to be axially movable. A gear **25** with/from which the second gear **6***c* engages/disengages is provided on the outer peripheral face of the rotor **12** (on the cylindrical portion **12***b* of the rotor **12**). When the rotation of the starter motor **4** is transmitted to the clutch **6** and causes the shaft **6***a* of the clutch **6** to rotate, the second gear **6***c* moves to engage with the gear **25** of the rotor **12**. The rotational force transmitted in this manner is transmitted to the crankshaft **5** through the rotor **12**.

It should be appreciated that gears in the starting mechanism provided between the starter motor and the crankshaft may be always in mesh with each other, and a one-way clutch is adapted to connect/disconnect transmission between the starter motor and the crankshaft. Alternatively, a stator motor containing a built-in clutch may be used. In brief, the clutch needs to be adapted to connect/disconnect transmission of the power between the stator motor and the crankshaft. In this embodiment, the gear **25** as an output end gear in a reduction gear train of the starting mechanism is provided on the outer periphery of the rotor **12**. But, the starting mechanism is not intended to be limited to the above, so long as the mechanism is adapted to rotate the crankshaft during the starting of the engine. For example, the starter motor may be installed at the rear portion of the engine in such a manner that the output end gear in the reduction gear train is attached to the bottom portion of the rotor **12**, the outer periphery of a member adapted to rotate in mesh with the crankshaft, or the crankshaft.

A sprocket **27** around which the cam chain **26** is installed is formed in the rear end portion **5***a* of the crankshaft body **5**A protruding into the generator chamber **8** in a portion between the first extended shaft member **15** and the rear end wall **7***a* having the penetrating hole **14** of the crankcase **7** such that the sprocket **27** is integral with the crankshaft **5**.

A front end portion **5***b* of the crankshaft body **5**A is rotatably supported by a penetrating hole **28** formed in the front end wall **7***b* of the crankcase **7** and protrudes through the penetrating hole **28**. The protruding portion of the front end portion **5***b* is covered by a sensor case **29***b* formed in the outer face of the front end wall **7***b* of the crankcase **7**. A rotation sensor **29***a* is attached to a sensor case **29***b*, for detecting a member **29***c* mounted to the front end portion **5***b*. According to the detection by the rotation sensor **29***a*, ignition timing or the like of the engine is controlled.

According to the above-mentioned structure, the generator **3** is placed at a position corresponding to the rear end portion **5***a* of the crankshaft **5** of the engine **1**, the starter motor **4** is placed on the outer face of the rear portion of the side wall of the crankcase **7**, and the clutch **6** for connecting/disconnecting the starter motor **4** to/from the crankshaft **5** is placed in the generator chamber **8**. This follows that the components **3**, **4**, **6** having relatively large weight are located on the rear end side of the engine **1**, and the center of gravity of the engine **1** is thereby located at the rear portion of the engine **1**. This is advantageous when the four-cycle engine is mounted in the personal watercraft.

The crankshaft **5** of this embodiment is comprised of the crankshaft body **5**A and the first extended shaft member **15**, which are connected to each other to be rotatable integrally with and separable from each other. This advantageously reduces the length of the crankshaft body **5**A of a complex shape so as to be easily manufactured. In addition, since the rotator **12** of the generator **3** is formed integrally with the first extended shaft member **15** having the output shaft end, the generator **3** is easily placed at the rear end portion of the crankshaft, and assembly is facilitated.

FIG. **2** shows an engine **31** according to another embodiment. The engine **31** is identical in structure to the engine **1** in FIG. **1** except that a cam chain tunnel **32** is provided on the front end side of the engine **31**. Therefore, the same components as those in the engine **1** in FIG. **1** are identified by the same reference numerals and will not be further described.

A front end portion **33***b* of a crankshaft body **33**A of a crankshaft **33** of the engine **31** is rotatably supported by a penetrating hole **35** formed in a front end wall **34***b* of a crankcase **34**. A second extended shaft member **36** is located in a front chamber **32**A that defines a cam chain tunnel **32** formed in a front portion of the front end wall **34***b* and is connected to a tip end of the front end portion **33***b* in such a manner that the second extended shaft member **36** is rotatable integrally with and separable from a crankshaft body **33**A. A sprocket **37** for cam chain is mounted to the second extended shaft member **36**. A front end face of the crankshaft body **33**A is substantially coplanar with an outer face of the front end wall **34***b* of the crankcase **34**. A convex portion **33***c* for fitting is formed in the front end face of the crankshaft body **33**A. A fitting hole **36***a* fitted over the convex portion **33**C, is formed in a rear end face of the second extended shaft member **36**. The convex portion **33***c* and the fitting hole **36***a* constitute so-called centering-location portion, where an outer peripheral face of the convex portion **33***c* is fitted to the corresponding inner peripheral face of the fitting hole **36***a* without substantial clearance. The fitting face is formed concentrically with a rotational center axis of the crankshaft **33**.

The second extended shaft member **36** is fitted to the front end of the crankshaft body **33**A and secured thereto by means of a bolt **38***a*. To prevent the second extended shaft **36** from rotating relatively to the crankshaft body **33**A, a pin **38***b* for preventing rotation is attached to the front end face of the crankshaft body **33**A.

A sprocket-mounting portion for mounting the cam sprocket **27** in FIG. **1** is not provided at a rear end portion **33***a* of the crankshaft body **33**A, but instead, the first extended shaft member **15** is exteriorly fitted to a portion of the crankshaft body **33**A outside a penetrating hole **14** of a crankcase **34**. The rotor **12** is mounted to the first extended shaft member **15** as in the crankshaft **5** in FIG. **1**. For sealing between the generator chamber **8** and an inner portion **34***b* of the crankcase **34**, a seal member **39** is attached to the penetrating hole **14** in the rear end wall **34***a* of the crankcase **34**. The sealing prevents an oil in the inner portion **34***b* of the crankcase **34** from flowing into the inside of the generator chamber **8**. As a result, loss of rotational energy of the generator **8** which would be caused by viscosity of the oil is avoided.

As should be appreciated, since the sprocket-mounting portion is not provided on the rear end portion **33***a* of the crankshaft body **33**A, the crankshaft **33** is shorter than the crankshaft **5** of the engine **1** in FIG. **1** substantially by difference between the length of the sprocket-mounting portion and the length of the seal member **39**.

Reference numeral **49***a* denotes a sprocket for driving a scavenging pump **49***b* or a feed pump **49***c* by means of a chain **49***d*.

FIG. **3** shows an engine **41** according to another embodiment. The engine **41** is identical in structure to the engine **31**

in FIG. **2** except for a mounting mechanism of a rotor **42**. Therefore, the same components as those in FIG. **2** are identified by the same reference numerals and will not be further described.

As shown in FIG. **3**, a screw portion **45***a* for connecting a first extended shaft member **44** and a centering-location portion **45***b* for causing a rotational center axis of the first extended shaft member **44** to conform to a rotational center axis of a crankshaft body **43**A are formed in a rear end portion **43***a* of the crankshaft body **43**A. The first extended shaft member **44** is provided with a connecting hole **44***a* for connecting the crankshaft body **43**A. The connecting hole **44***a* has an inner thread and a fitting portion inside thereof.

A small-diameter portion **47** is formed with a step portion **46** at the rear end portion **43***a* of the crankshaft body **43**A. The screw portion **45***a* and the centering location portion **45***b* are formed in the small-diameter portion **47**. A portion **45***c* of the small-diameter portion **47** between the centering location portion **45***b* and the step portion **46** is tapered with a diameter increasing toward the step portion **46**. The portion **45***c* is also expressed as a taper portion **45***c*. A rotor **42** of the generator **3** is cylindrical with a bottom. A cylindrical boss **42***d* having an inner peripheral face **42***a* to which the taper portion **45***c* is fitted is formed at a bottom portion of the rotor **42**. The inner peripheral face **42***a* is tapered to allow fitting to the taper portion **45***c*. The rotor **42** is first fitted to the taper portion **45***c*, and the first extended shaft member **44** is screwed to the screw portion **45***a* of the small-diameter portion **47**, thereby causing the rotor **42** to be pressed toward the large-diameter side of the taper portion **45***c*. As a result, the inner peripheral face **42***a* of the cylindrical boss **42***d* is fitted to the taper portion **45***c*, and thus, the rotor **42** is fixed to the taper portion **45***c* of the crankshaft body **43**A. A magnet **42***c* is fixed to an inner peripheral face of a cylindrical body portion **42***b* like the rotor **12** in FIGS. **1** and **2**.

A seal member mounting portion **14***a* is formed in a rear portion of the penetrating hole **14** formed in the rear end portion **48***b* of the crankcase **48**. Between an inner peripheral face of the seal member mounting portion **14***a* and an outer peripheral face of the cylindrical portion **42***d* of the rotor **42**, a seal member **39** is provided for sealing between an inside of the crankcase **48** and the generator **8**.

The crankshaft **43** is shorter than the crankshaft **33** of the engine **31** in FIG. **2** substantially by difference between the length of the rivet **20** (FIG. **2**) and the thickness of the flange **19** (FIG. **2**). Also, since the rotor **42** is independent of the first extended shaft member **44**, the first extended shaft member **54** is simply shaped.

FIG. **4** shows an engine **51** according to another embodiment. The same components as those in the engine **41** in FIG. **3** are identified by the same reference numerals and will not be further described. In the engine **51**, the rotor **42** is fixed to a crankshaft body **53**A by mounting a first extended shaft member **54** to a crankshaft body **53**A in such a manner that a rear end portion **53***a* of the crankshaft body **53**A is inserted into a connecting hole **54***a* of the first extended shaft member **54**. The engine **51** does not have the second extended shaft member **36**(FIG. **3**) unlike the engine **41** in FIG. **3**. In addition, the centering location portion is not formed in the portion where the rear end portion **53***a* of the crankshaft body **53**A is fitted to the first extended shaft member **54**.

The rear end portion **53***a* is connected to the first extended shaft member **54** by means of a screw portion **55**. A fitting hole **56***a* is formed on a rear end face of the crankshaft body **53**A and a fitting hole **56***b* is formed on the bottom of a connecting hole **54***a* provided on a front end of the first extended shaft member **54**. A shaft **57** for allowing a center axis of the crankshaft body **53**A to conform to the center axis of the first extended shaft member **54** penetrates into the fitting holes **56***a*, **56***b*. The fitting hole **56***a* is concentric with the crankshaft body **53**A and the fitting hole **56***b* is concentric with the center axis of the first extended shaft member **54**. Specifically, a centering-location portion for centering the first extended shaft member **54** and the crankshaft body **53**A is formed between an outer peripheral face of the shaft **57** and inner peripheral faces of the fitting holes **56***a*, **56***b*. By fittingly inserting the shaft **57** into the fitting holes **56***a*, **56***b*, the crankshaft body **53**A is caused to be coaxial with the first extended shaft member **54**.

With the above-mentioned structure, the crankshaft body **53**A is shorter than the crankshaft body **43**A in FIG. **3** substantially by the length of the centering-location portion in the rear end portion **43***a*.

Although the present invention has been described by way of example with reference to the accompanying drawings, it is to be understood that various changes and modifications will be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the invention, they should be construed as being included therein.

What is claimed is:

1. An engine of a personal watercraft, comprising:

a crankcase having a front end wall and a rear end wall;

a crankshaft provided inside the crankcase;

a generator chamber formed in a rear portion of the rear end wall of the crankcase;

a generator provided in the generator chamber, the generator being positioned at an output end portion of the crankshaft on a rear side of the engine, the generator including a rotor mounted to a portion of the output end portion of the crankshaft;

a coupling configured to be coupled to a propeller shaft of the watercraft, wherein the coupling is coaxially mounted outside the generator chamber and on a rear side of the rotor;

a starter motor provided on an output end side of the crankshaft outside the crankcase;

a clutch provided between the starter motor and the rotor of the generator, for connecting and disconnecting the starter motor to and from the rotor;

a cam chain tunnel formed on an opposite side of the output end side of the crankshaft;

a cam chain sprocket mounted to an end portion of the crankshaft on the opposite side of the output end side, the crankshaft passing through a penetrating hole formed in the front end wall of the crankcase and protruding into the cam chain tunnel; and

wherein the crankshaft passes through a penetrating hole formed in the rear end wall of the crankcase and the output end portion of the crankshaft protrudes into the generator chamber; and

wherein the output end portion of the crankshaft is configured to transmit a propulsion force for propelling the watercraft; and

wherein a seal member is provided in the penetrating hole of the crankcase to seal between an inside of the crankcase and the generator chamber.

2. The engine of a personal watercraft according to claim **1**, further comprising a water jacket formed in a housing

constituting the generator chamber to allow cooling water to flow therethrough.

3. An engine of a personal watercraft, comprising:

a crankcase having a front end wall and a rear end wall;

a crankshaft provided inside the crankcase;

a generator provided at an output end portion of the crankshaft, the generator including a rotor;

a starter motor provided on an output end side of the crankshaft outside the crankcase;

a clutch provided between the starter motor and the rotor of the generator, for connecting and disconnecting the starter motor to and from the rotor;

a generator chamber formed in a rear portion of the rear end wall of the crankcase, for containing the generator;

a cam chain tunnel communicating with an inside of the generator chamber;

wherein the rotor is mounted to the output end portion of the crankshaft passing through a penetrating hole formed in the rear end wall of the crankcase and protruding into the generator chamber;

a cam chain sprocket mounted to a portion of the crankshaft between the rotor and the penetrating hole;

wherein a water jacket is formed in a housing constituting the generator chamber to allow cooling water to flow therethrough.

4. An engine of a personal watercraft comprising:

a crankcase having a front end wall and a rear end wall;

a generator chamber formed in a rear portion of the rear end wall of the crankcase, for containing a generator;

a crankshaft provided inside the crankcase, the crankshaft including a crankshaft body having one end portion passing through the rear end wall of the crankcase and protruding into the generator chamber, and a first extended shaft member contained inside the generator chamber and having one end portion connected to the one end portion of the crankshaft body so as to be rotatable integrally with and separable from the crankshaft body and an opposite end portion protruding from the generator chamber outward relative to the generator chamber; and

a rotor-mounting portion formed integrally with the first extended shaft member, for mounting a rotor of the generator;

wherein the first extended shaft member constitutes an output end part of the engine.

5. An engine of a personal watercraft, comprising:

a crankcase having a front end wall and a rear end wall; a generator chamber formed in a rear portion of the rear end wall of the crankcase, for containing a generator,

a crankshaft provided inside the crankcase, the crankshaft including a crankshaft body having one end portion passing through the rear end wall of the crankcase and protruding into the generator chamber, and a first extended shaft member contained inside the generator chamber and having one end portion connected to the one end portion of the crankshaft body so as to be rotatable integrally with and separable from the crankshaft body and an opposite end portion protruding from the generator chamber outward relative to the generator chamber; and

a rotor-mounting portion provided at the one end portion of the crankshaft body protruding into the generator chamber, for mounting a rotor of the generator, the rotor of the generator being fixed to the rotor-mounting portion by mounting the first extended shaft member to the one end portion of the crankshaft body;

wherein the first extended shaft member constitutes an output end part of the engine.

6. The crankshaft of an engine for a personal watercraft according to claim **4**, further comprising a second extended shaft member connected to the other end portion of the crankshaft body to be rotatable integrally with and separable from the crankshaft body; and

a sprocket-mounting portion for mounting a cam-driving sprocket on the second extended shaft member.

7. The crankshaft of an engine for a personal watercraft according to claim **4**, further comprising:

a sprocket-mounting portion formed at the one end portion of the crankshaft body adjacent the first extended shaft member, for mounting a cam-driving sprocket of the engine.

8. The crankshaft of an engine for a personal watercraft according to claim **4**, wherein

a connecting hole is formed in an end portion of the first extended shaft member for connecting the crankshaft body by inserting the one end portion of the crankshaft body thereinto,

an outer peripheral face of the one end portion of the crankshaft body and an inner peripheral face of the connecting hole of the first extended shaft member respectively have a cylindrical fitting face for centering and an engagement portion for preventing circumferential relative rotation between the crankshaft body and the first extended shaft member, and

a center axis of the fitting face of the crankshaft body corresponds with a rotational center axis of the crankshaft and a center axis of the fitting face of the first extended shaft member corresponds with a center axis of the first extended shaft member.

9. The crankshaft of an engine for a personal watercraft according to claim **5**, further comprising a second extended shaft member connected to the other end portion of the crankshaft body to be rotatable integrally with and separable from the crankshaft body; and

a sprocket-mounting portion for mounting a cam-driving sprocket on the second extended shaft member.

10. The crankshaft of an engine for a personal watercraft according to claim **5**, wherein

a connecting hole is formed in an end portion of the first extended shaft member for connecting the crankshaft body by inserting the one end portion of the crankshaft body thereinto,

an outer peripheral face of the one end portion of the crankshaft body and an inner peripheral face of the connecting hole of the first extended shaft member respectively have a cylindrical fitting face for centering and an engagement portion for preventing circumferential relative rotation between the crankshaft body and the first extended shaft member, and

a center axis of the fitting face of the crankshaft body corresponds with a rotational center axis of the crankshaft and a center axis of the fitting face of the first extended shaft member corresponds with a center axis of the first extended shaft member.

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